

Tire Technology for Future Electric Vehicles

2019. 5. 9

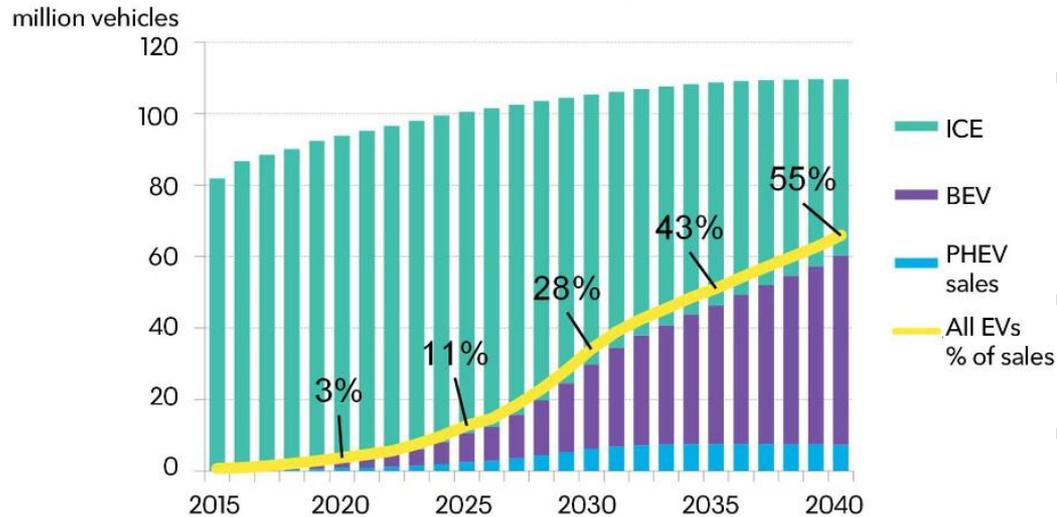
Hankook Tire



- **Introduction**
- **Electric Vehicle Characteristics**
- **Requirements for EV Tires**
- **EV Tire Technology**

EV Market Share Prediction

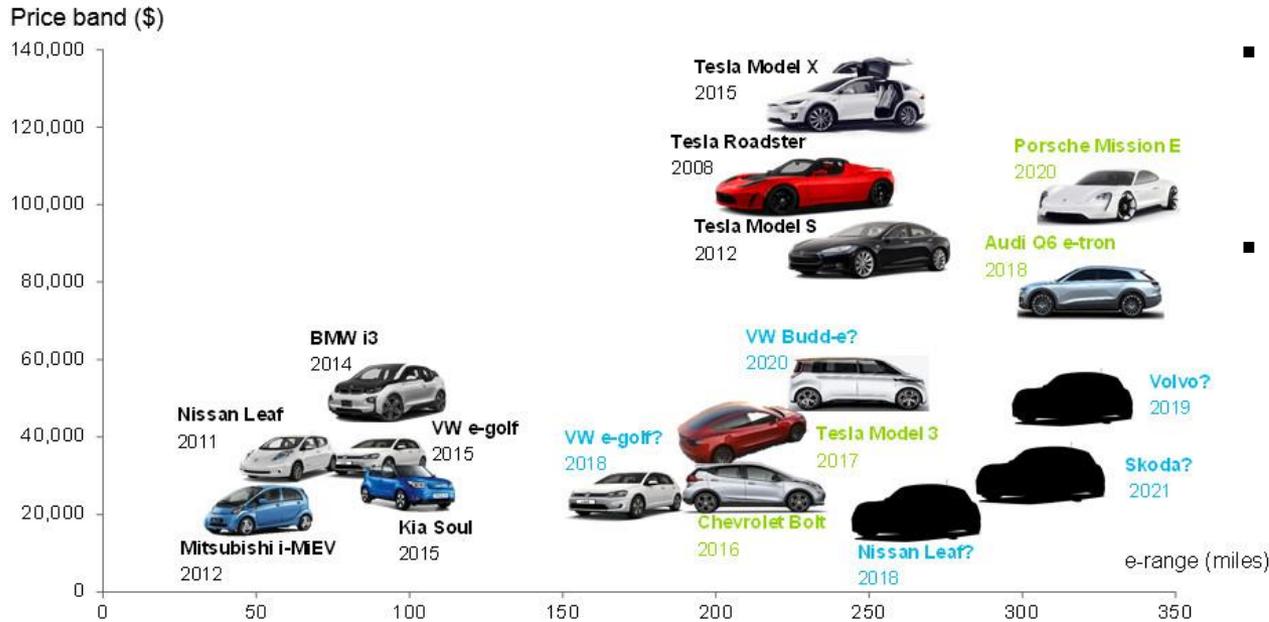
Annual global light duty vehicle sales



Source: Bloomberg New Energy Finance

- By 2040, 55% of new car sales and 33% of the global car fleet will be electric.
- China will lead this transition, with sales there accounting for almost 50% of the global EV market in 2025 and 39% in 2030.
- EVs become price competitive on an unsubsidized basis beginning in 2024.
- WLTP (CO₂: 2015 130g/km → '2020 95g/km)
In Year 2021, the total penalty: 4.5 bil EU

Electric Vehicle Characteristics – e-Range

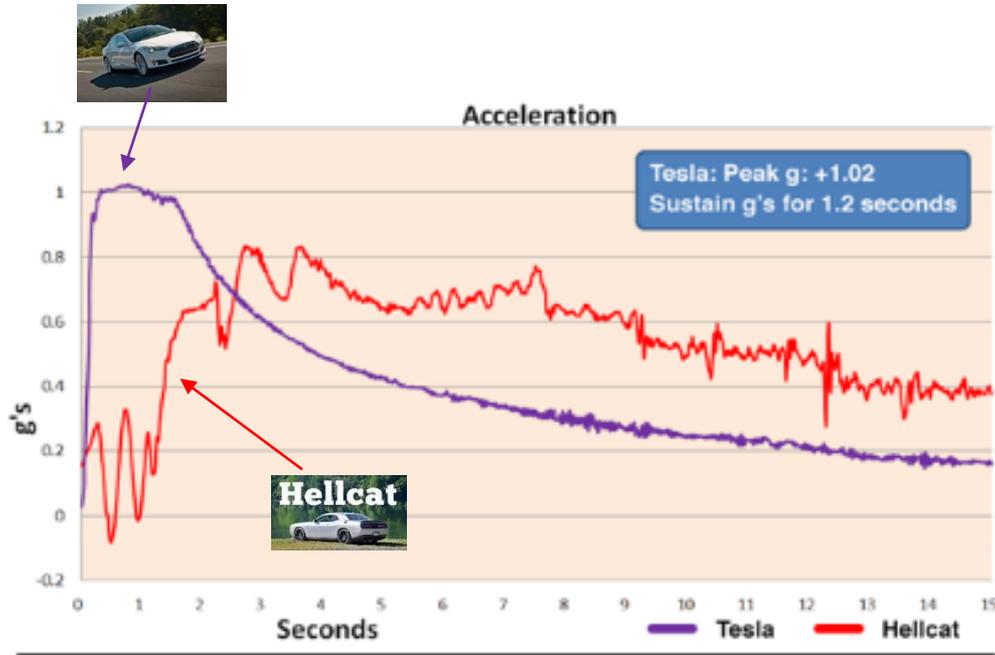


Note: Selected US battery electric vehicles (BEV) only. Positions are representative and do not indicate exact prices or range. Back labels = currently available, green labels = forthcoming models with specifications and timeline released. Blue labels = announced but limited details confirmed. Range is based on manufacturers statements, not on any specific test cycle.

Bloomberg
NEW ENERGY FINANCE

- e-Range is the primary concern for battery electric vehicles.
- Tire rolling resistance is responsible for 30% of energy consumption of EVs, which is much higher than that of ICEVs (7~10%).

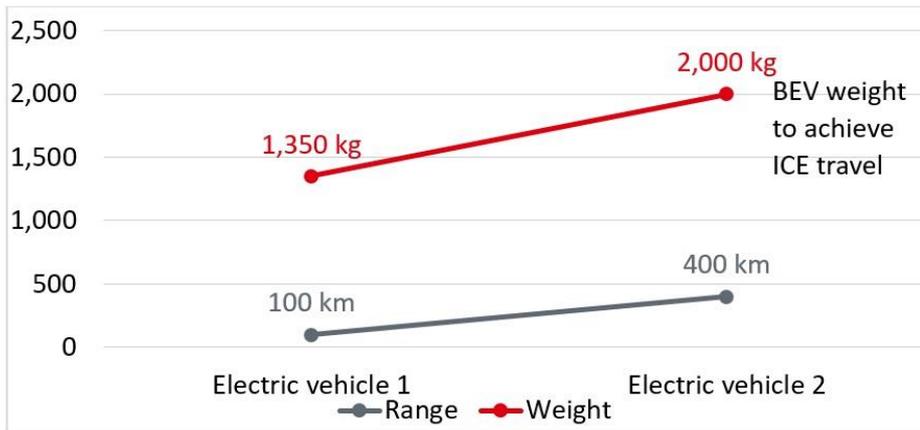
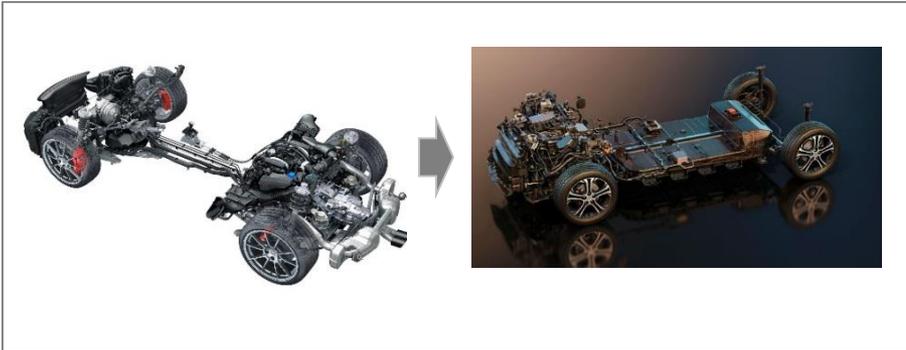
Electric Vehicle Characteristics – Traction



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- Electric motor can give higher initial torque compared to internal combustion engine.
- EVs has less delay in acceleration build-up than ICEVs.
- The higher torque may cause torque steer and excessive tire wear.

Electric Vehicle Characteristics – Weight

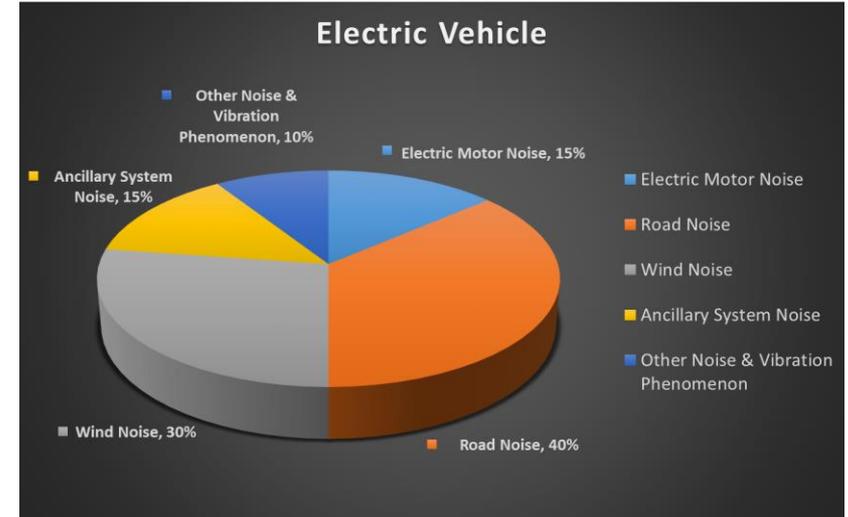
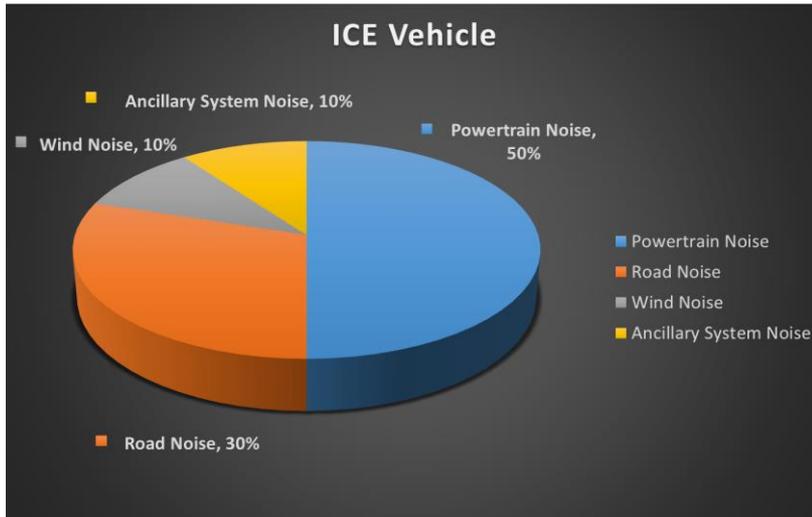


Source: Agronomy Research, 2017

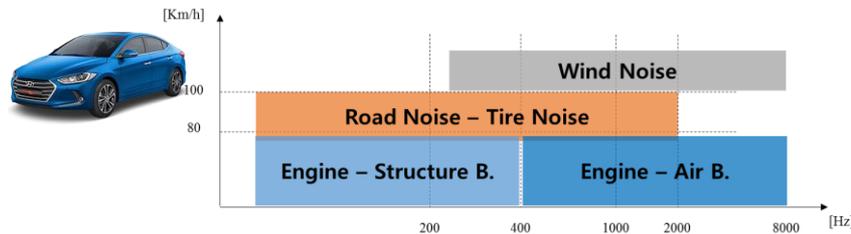
- Vehicle weight increases by 15% due to large size batteries.
- Increased performance of BEVs is tied to increase in battery weight, as batteries are getting larger to accommodate longer-range driving.
- The increased weight affects vehicle performances such as braking, handling as well as wheel design.

Electric Vehicle Characteristics – NVH

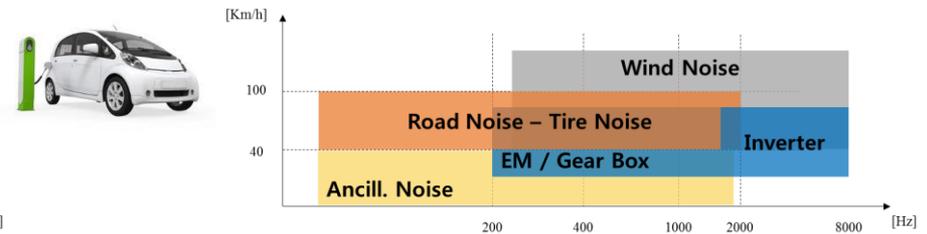
- No Powertrain Noise
- Road Noise, Wind Noise Contribution ↑



ICEV



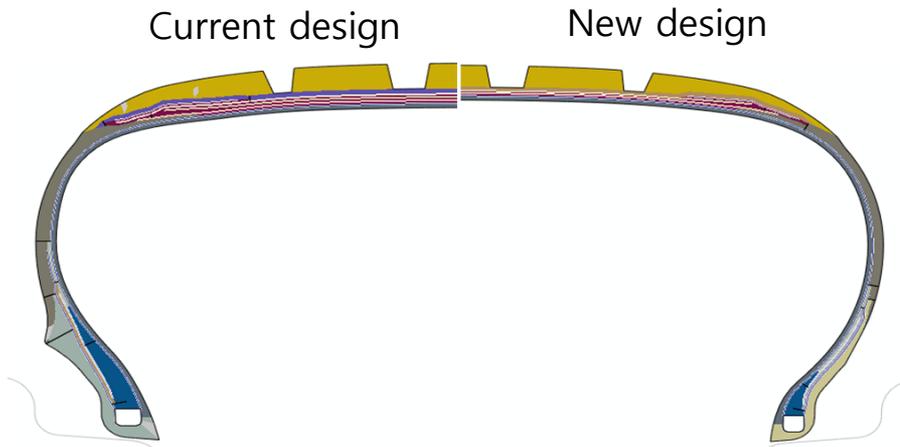
EV



Source : Leading the Charge – The Future of Electric Vehicle noise Control
Greg Goetchius, Sound & Vibration, April 2011

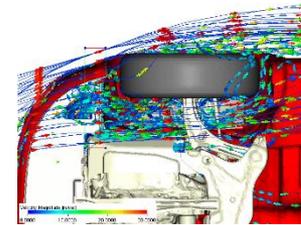
EV Tire Technology – LRR / Aerodynamics

- **LRR Tire design concept**



- Volume optimization
- Groove depth optimization
- New tread compound with eco-friendly material

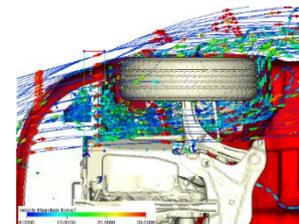
- **Aerodynamics**



Smooth Tire

Drag Contribution from tires

- Front Tires : 9%
- Rear Tires : 4%



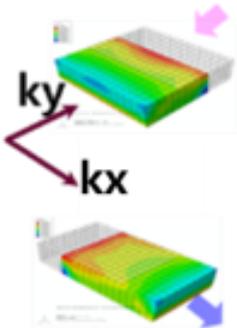
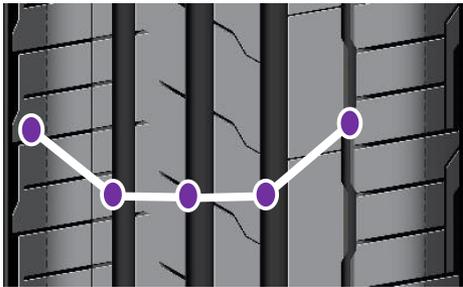
Patterned Tire

Drag Contribution from tires

- Front Tires : 13%
- Rear Tires : 5%

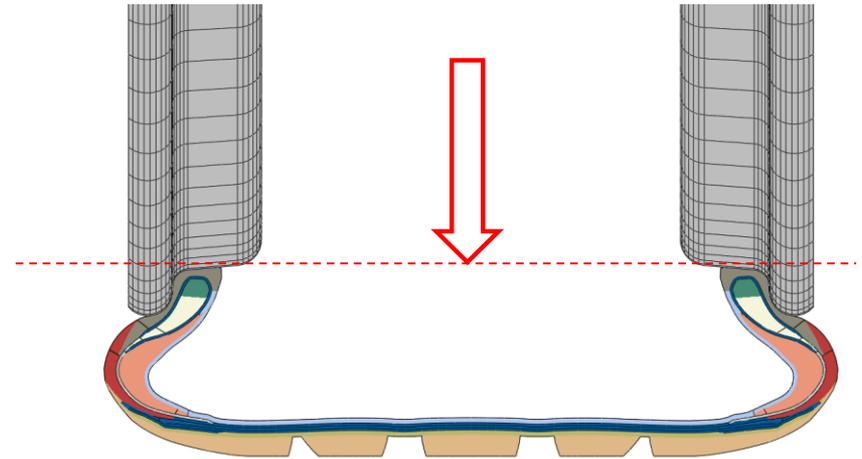
EV Tire Technology – Traction / Load Capacity

- Higher Block Stiffness (for Higher torque)



- Higher Load Capacity

12~13% increased load
compared with normal load



EV Tire Technology – NVH

- Pattern Technology



Anechoic wall



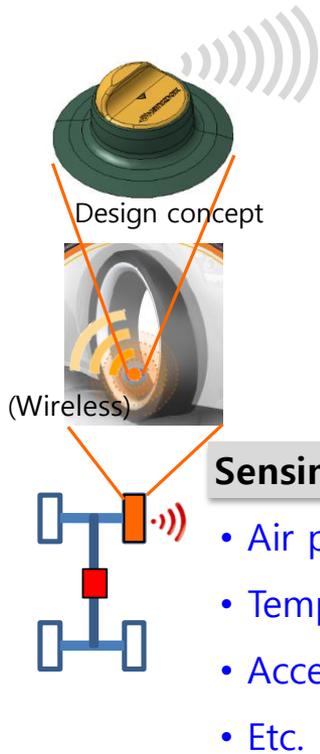
Block Pitch optimization

- Sound Absorber Technology

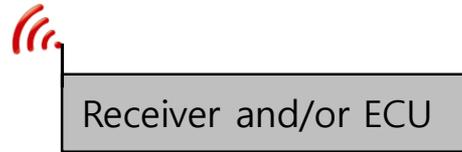


EV Tire Technology – Intelligent Tire System

i-Tire Sensing



Wireless Comm. and Estimation



Converting to Information

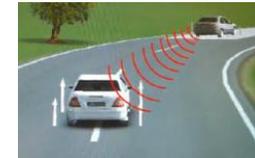


Application

Vehicle (Chassis System)



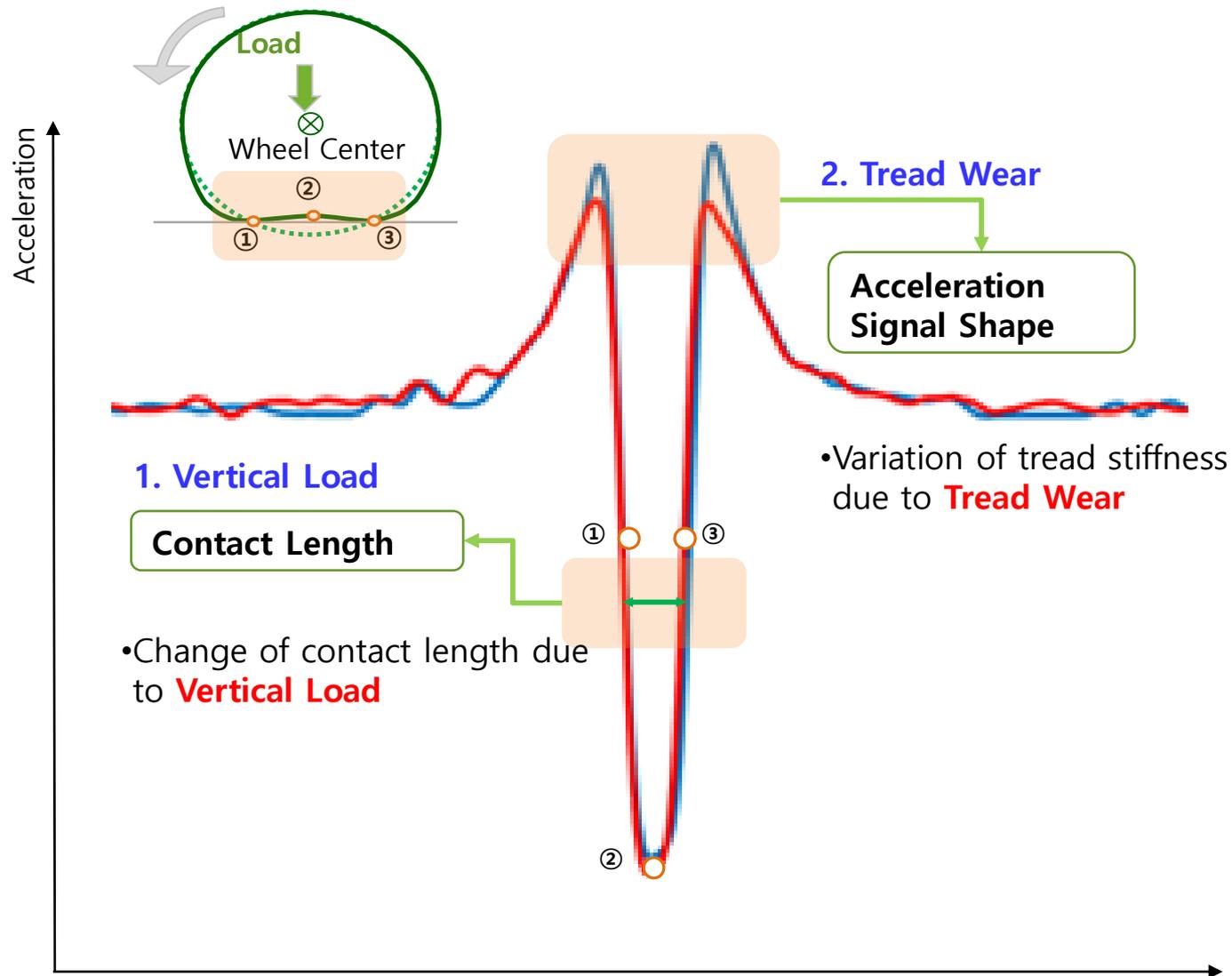
Telematics (V2V, V2I)



Driver



Estimation Technology – Vertical Load & Tread Wear



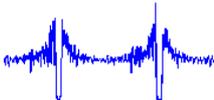
Estimation Technology – Road Condition



Input



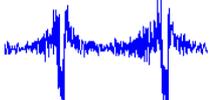
Dry



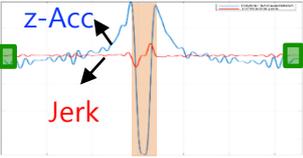
Acceleration



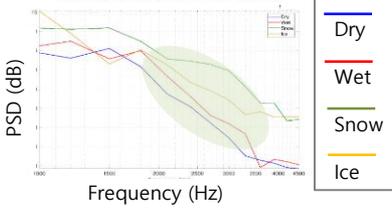
Snow



Acc. Signal

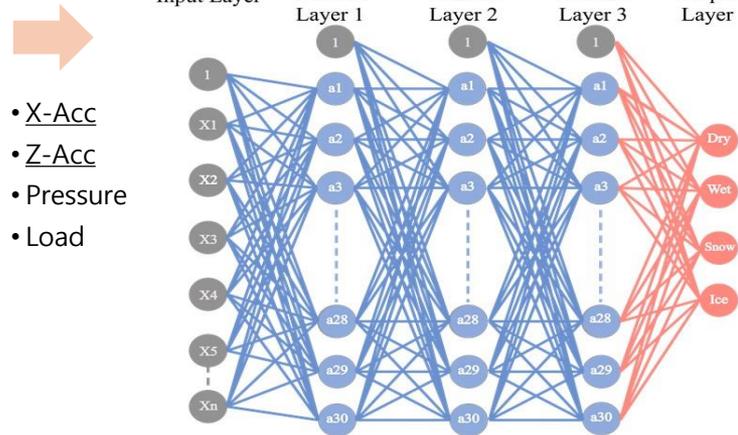


Freq. domain analysis



Algorithm Development

Machin Learning



- X-Acc
- Z-Acc
- Pressure
- Load

Result

Dry	Ice	Snow	Wet
83.0%	96.2%	95.6%	81.8%
Overall		89.1%	

Summary of EV Tire Technology



e-Range Demands

LRR

Aerodynamics

High Initial Torque

Traction

Battery Weight

Load Capacity

No Engine Noise

Low Noise

Connectivity

i-Tire

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